REVIEW

Regarding a PhD Thesis for the conferment of the educational and scientific degree "Doctor", Field of Higher Education 6. Agricultural Sciences and Veterinary Medicine, Professional Field 6.1. Crop Science, Scientific Specialty "Fodder production, meadow cultivation".

Author of the Thesis: Georgi Kraev Stanchev, Full-time Doctoral Student at the Department of Crop Science, Agricultural University – Plovdiv.
Field of Higher Education 6. Agricultural Sciences and Veterinary Medicine,
Professional Field 6.1 Crop Science,
Scientific Specialty "Fodder production, meadow cultivation".
Supervisors: Assoc. Prof. Atanas Sevov, PhD and Assoc. Prof. Lyubka Koleva-Valkova, PhD.

Thesis Title: "Investigation of the potential capacity of natural and artificial grasslands for CO_2 sequestration".

Reviewer: Prof. Tatyana Ivanova Bozhanska, PhD, Research Institute of Mountain Stockbreeding and Agriculture (RIMSA) – Troyan.
Field of Higher Education 6. Agricultural Sciences and Veterinary Medicine,
Professional Field 6.1. Crop Science,
Scientific Specialty "Fodder production, meadow cultivation".
Appointed as a member of the Scientific Jury by Order № RD-16-475 / 02.04.2026 of the Rector of the Agricultural University (AU).

I. Short presentation of the candidate

Georgi Kraev Stanchev was born on February 28, 1984. He completed his higher education at the Agricultural University – Plovdiv, where he earned a Bachelor's degree in "Agroforestry Systems and Mountain Agriculture" in 2015, followed by a Master's degree in "Crop Protection" in 2018.

His professional experience includes roles as a driver at "Triera" Ltd. – Plovdiv and "Martinelli" Ltd. – Varna (2004–2011). In 2016, he held the position of Inspector-Agronomist at "SGS Bulgaria Ltd." – Sofia, and from November 2017 to April 2018, he served as a Foreman at "Irrigation Systems Irisist" Ltd. – Sofia. Since November 2021, he has held the position of Assistant Professor at the Agricultural University – Plovdiv, focusing primarily on teaching activities.

Georgi Kraev Stanchev was enrolled as a full-time PhD student (Order № RD-26-40/03.04.2019) at the Department of Crop Breeding at the Agricultural University – Plovdiv. His doctoral research is in the scientific specialty "Fodder Production, Meadow Cultivation" (Professional Field 6.1 Crop Breeding) with a three-year term of study. In April 2022, he completed the program and was granted the right to defend his dissertation, effective from March 7, 2022 (Order № RD-26-30/04.04.2022).

The doctoral candidate possesses excellent training in the disciplines "English Language" (Parts I and II), "Teaching Methodology," and "Statistical Data Processing," as well as very good preparation in "Databases – Information Retrieval and Information Processing." He has also successfully completed an English language course for PhD students (3 modules, 90 hours, Level B2+ according to the CEFR) at the Department of Language

Training and Sports at the Agricultural University – Plovdiv (Certificate № K-15/16.02.2022) for the period 2019–2021.

Between June 12 and June 16, 2023, he conducted a short-term academic mobility at the Rezekne Academy of Technologies (Faculty of Engineering), Republic of Latvia, under the Erasmus+ program (training between program countries), and participated in the RTA International Week 2023.

II. The Actuality of the Problem

The issue of increasing atmospheric carbon dioxide (CO_2) concentration, alongside the processes of its sequestration and storage, has gained particular relevance within the context of sustainable agricultural landscape management under changing climatic conditions.

It has been established that the rise in greenhouse gas concentrations, particularly CO_2, resulting from anthropogenic activity, is a significant factor contributing to the enhancement of the greenhouse effect and subsequent long-term climate change. In this regard, the development and implementation of science-based, sustainable, and long-term strategies for limiting carbon emissions (and respectively restoring the balance of carbon fluxes) has emerged as a priority direction in contemporary scientific research.

Grassland ecosystems occupy a significant portion of the Earth's land surface and perform key ecological and biogeochemical functions. Their role as nature-based mechanisms for the sequestration and accumulation of organic carbon in soil horizons is globally comparable to that of forest ecosystems and depends on their condition, management regime, and climatic conditions. The complex of factors determining the intensity and stability of these processes is yet to be fully elucidated and systematized.

Existing research on the carbon balance is primarily focused on assessing carbon stocks and the impact of various land-use practices. At the same time, studies concerning the potential of grasslands to sequester and accumulate CO_2 remain limited in scope and depth, necessitating more systematic and comprehensive research in this field.

The research presented in this doctoral thesis addresses practically significant issues related to the potential of components in natural and artificial grasslands for CO_2 capture and soil storage, aiming to mitigate the negative effects of global warming and maintain long-term ecological equilibrium. The results obtained can be utilized in developing models for the identification and characterization of carbon pools, as well as in assessing the contribution of pastures and meadows to climate change mitigation.

The topic is both timely and scientifically significant, combining theoretical and applied aspects while aligning with modern priorities in the field of ecology and the sustainable management of agroecosystems.

III. Aim, objectives, hypotheses and research methods

The aim of the doctoral thesis is clearly formulated and focused on investigating the capacity of natural and artificial grasslands for carbon sequestration and accumulation. To achieve this aim, the following main objectives have been defined:

- Investigating the capacity for carbon (C) sequestration and storage in natural grasslands;
- Investigating the capacity for carbon (C) sequestration and storage in artificial grasslands;
- Establishing the correlation between climatic conditions, species composition, and carbon accumulation in plants and soil.

The experimental work was conducted across four research sites: the city of Plovdiv (artificial grassland), the town of Devin, the village of Rozino, and the Beklemeto area –

Troyan (natural grasslands). The studied regions are situated within a wide altitudinal range (from 156 to 1538 m) and are characterized by specific features regarding climate, relief, exposure, soil type, and floristic composition.

The research parameters (species composition, basal cover of the grasslands, soil organic carbon content, and the dynamics of CO_2 fluxes per unit area) are clearly defined and correspond to the set aim and the methods for their determination. A detailed agro-climatic and soil characterization of the investigated territories is provided.

Data processing involved the application of Multiple Regression analysis and the F-test (Fisher's criterion). The developed regression models are characterized by high values of multiple correlation and determination coefficients, indicating a strong linear dependence between the studied variables (X and Y).

The methodological approach is appropriately selected and aligns with the established aims and objectives. The tools used for data collection and processing are contemporary and yield a high degree of empirical evidence, allowing for the attainment of reliable and scientifically grounded results.

IV. Illustration and presentation of the obtained results

The doctoral thesis is developed in a format and volume that comply with the requirements of the Higher Education Act of the Republic of Bulgaria and the Regulations for the Application of the Act on the Development of the Academic Staff at the Agricultural University – Plovdiv.

The structure of the work includes: a title page, table of contents (2 pages), introduction (3 pages), literature review (36 pages), aim and objectives (1 page), material and methods (7 pages), soil characteristic (6 pages), results and discussion (80 pages), conclusions (3 pages), contributions (2 pages), and references (35 pages). The individual sections are logically and sequentially linked and thoroughly developed.

The total volume of the dissertation is 175 pages. The introduction is focused, providing an overview of the subject matter, the object, and the aim of the study. The largest relative share is occupied by the "Results and Discussion" section (48% of the total volume), in which the author presents the findings of the conducted research in a clear and logically consistent manner. The data from the analyses are systematized and illustrated in 37 tables and 61 figures, which facilitates their objective interpretation and reveals the established correlations between the research parameters. The presentation of the results is aligned with the methods used for data collection and processing, supporting both the analysis of primary data and the derivation of reliable statistical generalizations.

V. Discussion of Results and Literature Used

The "Results and Discussion" section consists of nine subsections:

i) Agrometeorological characterization of the meteorological conditions in the studied regions during the experimental period;

ii) Study of the species composition and basal cover of the grasslands;

iii) Determination of soil carbon content;

iv) Determination of CO_2 absorption activity per unit area;

v) Determination of the diurnal variation of CO_2 fluxes;

vi) Determination of diurnal fluctuations in soil respiration;

vii) Investigation of the capacity for carbon (C) sequestration and storage in natural and artificial grasslands;

viii) Establishing the correlation between climate, species composition, and carbon accumulation in plants and soil;

ix) Statistical processing of the results.

The discussion of the results is structured in accordance with the established aims and objectives, characterized by logical consistency and scientific argumentation. The discussion is profound and cross-referenced with relevant literature, providing the necessary theoretical foundation.

The thesis presents a systematic and methodologically sound analysis of agro-climatic conditions and their influence on the functioning and stability of grassland ecosystems. Data were analyzed by year and by altitudinal gradient, allowing for spatial comparison and revealing dependencies between the structural characteristics of the grasslands and their potential for carbon accumulation. Drought risks in lowland areas and the more favorable water regimes in mountain ecosystems were assessed in relation to ecological stability, CO_2 fixation capacity, and soil organic carbon accumulation. A proven correlation was established between moisture availability, temperature regime, and carbon accumulation processes.

The author monitors the dynamics of key structural indicators of the grasslands—basal cover, height, and species diversity—as well as the ratio between functional groups (grasses, legumes, and weeds). The interpretation is conducted within the context of phytocoenotic dynamics, productivity, resilience, and the self-regulation capacity of the grassland communities. The trend toward increased species diversity and the formation of complex semi-natural grasslands, including in experimental plots with established grass mixtures, is well-argued.

There is strong consistency between the results obtained and the biotic (species composition, grassland density) and abiotic factors, allowing for a comprehensive interpretation of processes related to soil carbon accumulation. The analysis is consistent and scientifically grounded, contributing to a fuller understanding of the role of grassland ecosystems in CO_2 sequestration. In this context, the spatial differentiation between the studied sites highlights mountain ecosystems as effective carbon sinks. The Beklemeto area is characterized by the highest potential for carbon accumulation, driven by specific soil-climatic conditions, rich phytocoenotic diversity, and the density and functional structure of the natural grassland. Maximum values were recorded in spring (up to 12.84%) and autumn (up to 15.98%) under optimal conditions for photosynthetic activity. It should be emphasized that grasslands in mountain regions sequester a significant portion of carbon in the soil due to well-developed root systems (mass) and relatively slow mineralization of organic matter, which increases their value as long-term carbon reservoirs.

The use of multiple linear regression analysis to assess the influence of key environmental factors (temperature, humidity, and species composition) on CO_2 sequestration and soil respiration is methodologically justified and aligns with modern approaches in ecological research. The comparative approach between specific experimental years tracks the role of climatic factors and enables the development of a regression model for assessing carbon exchange in the studied grassland communities. The results obtained possess high scientific and practical value.

The scientifically grounded conclusions (15 in total) clearly define the interrelationships between climatic factors, grassland community structure, and the carbon balance, emphasizing the need for an integrated approach to grassland management. This approach should focus on maintaining plant diversity, optimizing land use, and preserving soil carbon stocks, which are identified as key elements in climate change mitigation strategies.

The literature cited includes 288 sources, of which 10 (3.5%) are in Cyrillic and 278 (96.5%) are in Latin script. This is undeniable evidence of the doctoral candidate's excellent literary awareness and theoretical training. Furthermore, the candidate demonstrates the ability to logically interpret the main highlights of the respective literature sources.

VI. Contributions to the dissertation thesis

The candidate has formulated contributions of a scientific-theoretical nature (9 in total) and a scientific-applied nature (10 in total). I accept them as well-argued and justified, possessing substantial value for theoretical research and demonstrating strong practical applicability. The most significant among them are presented in the following summarized form:

Scientific-Theoretical Contributions:

1. A concept has been presented regarding the spatial differentiation of agro-climatic conditions relative to altitude and their impact on the duration of the growing season, cumulative temperature sums, and precipitation regimes. This approach significantly enriches theoretical understanding of the effects of climate dynamics on the patterns of spatial organization and the structural-functional differentiation of grassland phytocoenoses.
2. The author demonstrates a significant contribution from an ecological perspective by proving the link between species diversity, the functional structure of plant communities, and their resilience and self-regulation. Particularly valuable is the assessment of the role of key functional plant groups (grasses, legumes, and weeds) in creating productive and sustainable grassland ecosystems.
3. A substantial theoretical contribution is the analysis of carbon cycle processes within grassland communities by investigating the relationship between photosynthesis, soil respiration, and carbon accumulation. The established dependencies between climatic factors and the intensity of carbon exchange highlight the primary role of temperature and moisture; furthermore, the differentiation between grasslands with high instantaneous productivity and those with potential for long-term carbon storage is particularly applicable to sustainable ecosystem management.
4. The further development of the concept of mountain grassland communities as stable carbon reservoirs is convincingly justified within the context of global climate change and represents a significant contribution to contemporary ecological and climatic research.

Scientific-Applied Contributions:

1. The agro-climatic assessment and spatial analysis of regions at different altitudes provide a reliable basis for optimizing land-use planning and management.
2. The integrated approach for evaluating the ecological stability of grassland communities—based on the synthesis of species diversity indicators, structural characteristics, climatic conditions, photosynthetic activity, and soil respiration—can be utilized in the development of sustainable ecological practices.
3. The analysis of drought risk in lowland areas allows for the identification of zones with more favorable water regimes and high significance for the adaptive management of grassland ecosystems.
4. The quantitative assessment of the potential of natural and artificial grasslands to sequester CO2 is applicable in developing measures to mitigate climate change impacts, while the seasonal dynamics of organic carbon serve as a determining factor for monitoring soil fertility and carbon balance.
5. The role of biodiversity is emphasized in identifying phytocoenoses with high potential for long-term carbon storage, which are used for restoring and optimizing the carbon balance.
6. A regression model has been developed to evaluate the influence of climatic and environmental factors on carbon exchange within grassland communities.

7. The results obtained have a clear practical orientation and can be effectively utilized in the development of strategies for climate change adaptation and the sustainable management of agroecosystems.

VII. Critical remarks and questions

I have no critical remarks or questions for the doctoral candidate.

VIII. Published articles and citations

Based on the statement of the Commission for Verification of Scientometric Indicators (Orders: № RD 16 - 670/15.06.2022 and № RD -16- 804/09.10.2020), I note that there are three scientific publications related to the doctoral thesis. These meet the minimum national requirements and cover the scientometric indicators (by points) according to Art. 2b of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB) for the acquisition of the educational and scientific degree "Doctor" (PhD).

The articles were published between 2024 and 2026 in editions included in the National Reference List of NACID, as well as in journals refereed and indexed in internationally recognized databases for scientific information (Scopus). In one of the articles, the doctoral candidate is the sole author, while in the others, he is a co-author with his scientific supervisor.

The submitted abstracts (in Bulgarian and English) objectively reflect the structure and content of the doctoral thesis. They include the main sections and results, as well as the formulated conclusions and scientific contributions. Their volume is 38 pages (BG) and 30 pages (EN), respectively, featuring 6 tables and 18 figures.

CONCLUSION:

Based on the diverse research methods learned and applied by the doctoral candidate, the correctly executed experiments, and the derived generalizations and conclusions, I consider that the submitted doctoral thesis meets the requirements of the Act on the Development of the Academic Staff in the Republic of Bulgaria (ADASRB) and the Regulations of the Agricultural University for its application. This provides me with sufficient grounds to give it a **POSITIVE** evaluation.

I hereby propose to the honorable Scientific Jury to also vote positively and to award **Georgi Kraev Stanchev**—a full-time doctoral student at the Department of Plant Breeding at the Agricultural University – Plovdiv—the educational and scientific degree "Doctor" in the scientific specialty "Fodder production, meadow cultivation."

27.04.2026

Plovdiv